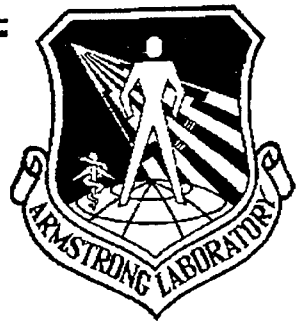
AL/HR-TP-1995-0003



DEVELOPMENT AND EVALUATION OF A TASK TAXONOMY TO SUPPORT RESEARCH ON CROSS-JOB TRANSFERABILITY OF SKILLS

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February 1995

Final Technical Report for Period June 1989 - April 1994

AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS

ARMSTRONG LABORATORY

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The Office of Public Affairs has reviewed this paper, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This paper has been reviewed and is approved for publication.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	February 1995	Interim Paper - June 1989 - August 1993

4. TITLE AND SUBTITLE

Development and Evaluation of a Task Taxonomy to Support Research on Cross-Job Transferability of Skills

5. FUNDING NUMBERS

C - F49620-87-R-0004
PE - 62205F
PR - 7719
TA - 19
WU - 27

6. AUTHOR(S)

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8. PERFORMING ORGANIZATION REPORT NUMBER

AL/HR-TP-1995-0003

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

Armstrong Laboratory (AFMC)
Human Resources Directorate
Manpower and Personnel Research Division
7909 Lindbergh Drive
Brooks AFB TX 78235-5352

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Armstrong Laboratory Technical Monitor: Dr Bruce Gould, (210) 536-2912.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This paper describes a comprehensive effort to develop a common taxonomy of tasks performed by US Air Force (USAF) enlisted personnel for the purpose of supporting a program of research on cross-job transferability of skills. Information was integrated from several sources, including: (a) a rational task taxonomy developed previously by the USAF Occupational Measurement Center (USAFOMC) using subject matter experts (SMEs), (b) data collected from 675 other SMEs on a questionnaire measuring the skills/knowledge requirements of 47 Air Force jobs, (c) data collected from 2122 airmen on the General Work Inventory, (E) existing work taxonomies, and (F) expert judgment. Empirical support was obtained for the resulting 26-category taxonomy in terms of (a) its face validity, (b) reliability of its descriptive categories, (c) empirical distinctness of the task categories, and (d) validity of job clusters formed on the basis of task category profiles.

14. SUBJECT TERMS

Task taxonomy
Taxonomy
Transferability of skills

15. NUMBER OF PAGES

41

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

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PREFACE

This research was sponsored by the Air Force Office of Scientific Research/AFOSR, United States Air Force, under contract F49620-87-R-0004, and the Manpower and Personnel Research Division, Human Resources Directorate, Armstrong Laboratory, Brooks Air Force Base, TX, project 77191927, Development of MPT Acquisition Tradeoff Methods.

The research was completed while the first author was a Summer Faculty Research Fellow, the second author was a Summer Research Assistant, and the third author was a Visiting Scientist, in the Manpower, Personnel, and Training (MPT) Integration Branch of the Manpower and Personnel Research Division.

An earlier version of this paper was presented at the April 1989 meeting of the Society for Industrial and Organizational Psychology, Boston, MA.

The authors wish to thank Wayne Archer for his help in various aspects of this work and Rob Mahan and a range of reviewers for their helpful comments on an earlier version of this paper. We also acknowledge the support of the Business School, Dublin City University in the preparation of this paper.

DEVELOPMENT AND EVALUATION OF A TASK TAXONOMY TO SUPPORT RESEARCH ON CROSS-JOB TRANSFERABILITY OF SKILLS

INTRODUCTION

The increasing need to retrain employees laterally across jobs, driven by technology advances, mergers, and acquisitions, has led to a need for a procedure to estimate the cross-job transferability of skills. This problem is particularly acute in the Armed Forces due to decreasing troop strength ceilings and rapid technological changes. Unfortunately, a methodology has yet to be developed which identifies optimal cross-job retraining strategies.

Cross-job transferability of skills has been linked theoretically to interjob similarity (Fine, 1957a, 1957b). In turn, interjob similarity has been shown to relate positively to performance in a new job (Gordon & Fitzgibbons, 1982) and negatively to training time required on a new job (Gordon, Cofer, & McCullough, 1986). One way in which interjob similarity can be assessed is in terms of task content, and associated task learning times (Kavanagh & Gould, 1989). However, estimating interjob similarity in this way requires a common taxonomy of tasks to facilitate cross-job comparisons (Fleishman, 1984; Dunnette, Hough, & Rosse, 1979). The purpose of this article is to describe the development and evaluation of such a taxonomy for research on interjob similarity and cross-job transferability of skills across USAF enlisted jobs.

A task taxonomy can be defined in terms of a scheme by which tasks and subtasks are classified into a logical framework (Companion & Corso, 1982) or a means of classifying tasks in such a way that useful relations among them are established (Miller, 1967). Dozens of work taxonomies have been proposed (e.g., Campion & Thayer, 1985; Companion & Corso, 1982; Cunningham, 1988; Cunningham, Boese, Neeb, & Pass, 1983; Dawis & Lofquist, 1975; Dunnette, 1976; Farina, 1973; Farina & Wheaton, 1973; Fleishman, 1972, 1982; Fleishman & Quaintance, 1984; Holland, 1973; McCormick, 1976; McKinlay, 1976; Peterson & Bownas, 1982; Ramsay-Klee, 1979; Ruck, 1986; Stolurow, 1964; Wheaton, 1973). Some of these are intended to be broadly applicable to the world of work (e.g., Cunningham et al., 1983) while others were developed for more circumscribed work domains and/or classificatory purposes (e.g., Bennett, 1971; Dowell & Wexley, 1978; Ramsey-Klee, 1979). General taxonomies often have limited usefulness in specific organizations, while the more circumscribed ones lack generalizability beyond the specific purpose for which they are developed. For these reasons, our review of this literature (Mayfield & Lance, 1988) failed to identify an existing taxonomy that was wholly appropriate for the purpose of conducting cross-job task content comparisons across Air Force Specialties (AFSs), pointing to the need for the present research.

Literature on classification suggests several steps in the development of an empirically validated taxonomic system, including: (a) specification of the purpose for classification, (b) identification of the population of objects to be classified, (c) specification of the relevant characteristics of objects to be considered in classification, (c) development of some means for measuring these characteristics, (d) collection of data on a sample from the population of objects to be classified, (e) empirical identification of classificatory dimensions or categories, and (f) cross-validation of the classificatory scheme on additional samples (Aldenderfer & Blashfield, 1984; Milligan & Cooper, 1987; Sokal, 1974).

In the present context, this would have required the development of an Air Force-wide job inventory, large-scale data collection on a large number of Air Force Specialties (AFSs, i.e., jobs), empirical identification of task dimensions, and cross-validation of findings in a second sample of AFSs. However, time, budgetary, and manpower constraints precluded this large-scale effort. Also, use of existing USAF Occupational Survey data base (Christal, 1974) was not feasible. This data base is probably the largest task-level job analysis data base in the world (Christal, 1974) but its usefulness for assessing job content similarities <u>across</u> AFSs is extremely limited, since separate job inventories are developed for each separate career ladder or job family.

Rather, we took an eclectic approach in developing a task taxonomy that integrated information from several sources, including use of (a) an existing set of rationally defined task categories developed by the USAF Occupational Measurement Center (Bell & Thomasson, 1984), (b) data collected in this present study from 675 subject matter experts (SMEs) on a questionnaire measuring the skills/knowledge requirements of 47 Air Force jobs, (c) an existing data set collected in 1982 from 2,122 airmen in 180 AFSs on the General Work Inventory (Ballentine & Cunningham, 1981), (d) an existing set of data collected from 2494 airmen on an Electronics Principles Inventory (Ruck, 1977, 1986), (e) existing literature on task taxonomies (Fleishman & Quaintance, 1984), and (f) expert judgment. Finally, we evaluated the usefulness of this taxonomy, using additional data collected in July 1989 on a second survey of AFSs' skills and knowledge requirements. Each of these sources of information and its contribution to the development of the taxonomy is a described in the following sections.

DEVELOPMENT OF THE TAXONOMY

USAF Occupational Measurement Center (USAFOMC) Job Categorization Project

The first source of information for this study was a set of task categories developed by the USAFOMC. The USAF uses four Armed Sevices Vocational Aptitude Battery (ASVAB) selector composites (Mechanical, Administrative, General,

and Electronic [MAGE], Department of Defense, 1984) for classification purposes, and each AFS is classified according to one or more of these aptitude areas. The primary purpose of the USAF Occupational Measurement Center (USAFOMC) Job Categorization Project was to "determine the proper job category for each AFS based on the jobs/tasks actually performed" (Bell & Thomasson, 1984, p. 1). It was determined that four job categories (i.e., the MAGE areas) were "too broad to adequately describe the components or work characteristics of all jobs or specialties" (p. 1). Rather, USAFOMC scientists defined 26 subcategories that appeared to describe interjob similarities and differences in task content more meaningfully. The usefulness of these task subcategories was initially assessed using a modification of Smith and Kendall's (1963) retranslation technique in which, iteratively, task categories were defined, and tasks which comprised 50 percent of the total job time for 217 AFSs were categorized (Bell & Thomasson, 1984).

Subsequently, this task category list was revised to include Supervisory and Training categories, and so that redundancy within one category was eliminated (three Mechanical categories had been defined which differed only in terms of complexity). Category names and definitions included in this revised taxonomy are shown in Table 1. Preliminary work with this taxonomy supported its usefulness for categorizing enlisted AFSs' tasks (Gould, Archer, Filer, Short, & Kavanagh, 1989), and for developing cross-AFS retraining time estimates (Lance, Kavanagh, & Gould, 1989).

Skills/Knowledge Questionnaire

The USAFOMC 26 task category taxonomy (shown in Appendix A) formed the basis for the second data source. A Skills/Knowledge Questionnaire (SKQ) was designed and administered in this present study to evaluate this taxonomy and to develop methods for estimating cross-AFS retraining time. The SKQ was designed to solicit three judgments from SMEs for each of the 26 task categories: (a) a binary "Part-of-job" (POJ) rating (yes/no), (b) Relative Time Spent (RTS) performing tasks within categories endorsed as part of the job ("1 - Very small amount," to "9 - Very large amount"), and (c) average months to proficiency for a newly assigned airman on tasks included in each category ("1 - 0-1 Months" to "9 - 9 or more months"). Raters were instructed to consider a typical journeyman-level of proficiency for the job duties in completing the SKQ.

Data Collection

In May 1988, the SKQ, along with a cover letter, detailed rating instructions, and rating category definitions, was mailed to 1,356 supervisors in 47 AFSs. Since one of the purposes of the SKQ was to develop a prototype method for estimating cross-AFS retraining time, the 47 AFSs targeted for data collection had the highest rates of retraining, either "out of" - to another AFS, or "in to" - from another AFS over

the previous 2 years. These are listed in Table 1. Potential survey participants were identified by randomly selecting thirty supervisors' names for each AFS from personnel records. For AFSs in which there were fewer than thirty supervisors Air Force-wide, all were selected as potential respondents. Study participation was entirely voluntary.

Table 1. Air Force Specialties Surveyed With the SKQ

AFSC	Specialty Title
113x0C	Flight Engineer
122x0	Aircrew Life Support
207x1	Morse Systems Operator
241x0	Safety Specialist
242x0	Disaster Preparedness
251x0	Weather Specialist
272x0	Air Traffic Control Operator
274x0	Command and Control Specialist
275x0	Tactical Command and Control Spec
304x0	Wideband Communication Equip Spec
305x4	Elec Component & Switching Sys Spec
306x0	Elec Commun & Crypto Equip Sys Spec
411x0c	Missile Systems Maintenance Spec
411x1a	Missile Maintenance Specialist
426x2	Jet Engine Mechanic
431x1	Tactical Aircraft Maintenance Spec
431x3	Airlift Aircraft Maintenance Spec
451x4	F-15 Avionics Test Stn & Comp Spec
451x5	F-16/A-10 Avionics Test Stn & Comp Spec
451x6	F/FB-111 Avionics Test Stn & Comp Spec
454x3	Fuel Systems Maintenance Specialist
456x1	Electronic Warfare Systems Specialist
472x4	Vehicle Maintenance Con & Analysis Tech
491x1	Communication-Computer Systems Operator
491x2	Communication-Computer Systems Programmer
492x1	Information Systems Radio Operator
493x0	Communication-Computer Systems Control
496x0	Comm-Comp. Systems Program Mgt Spec
603x0	Vehicle Operator/Dispatcher
645x1	Materiel Storage & Distribution Spec
645x2	Supply Systems Analysis Specialist
651x0	Contracting Specialist
661x0	Logistics Plans Specialist
702x0	Administration Specialist
705x0	Legal Services Specialist
732x0	Personnel Specialist
733x1	Manpower Management
751x1	Training Systems Specialist
811x0	Security Specialist
811x2	Law Enforcement Specialist
903x1	Nuclear Medicine Specialist

Note. AFSC = Air Force Specialty Code.

Results

Surveys were returned by mail in June 1988 from 675 respondents for a response rate of 50%. The typical SME was male (91%), had some college education (mean education 13.49 years, SD = 1.46), supervised four persons (mean = 4.11, SD = 8.03), had been in the job over 3 years (mean = 38.09 months, SD = 33.22), and in the service over 15 years (mean Total Active Federal Military Service = 182.81 months, SD = 57.47 months).

Descriptive statistics for SKQ POJ and RTS ratings are shown in Table 2.

Table 2. SKQ Part-of-Job and Relative Time Spent Descriptive Statistics and Intraclass Correlations

Category	Part of Job	Relative Time Spent		ICC (1,k)
		Mean	S.D.	
1. Clerical	84%	3.94	2.64	.852
2. Computational	73%	3.13	2.67	.817
3. Office Equip Oper	73%	3.06	2.68	.848
4. Mechanical	51%	2.61	3.11	.885
5. Simple Mech	53%	2.54	2.87	.827
6. Complex Mech	39%	2.18	3.09	.792
7. Mech-Electrical	28%	1.29	2.35	.884
8. Mech-Electronic	27%	1.34	2.49	.772
9. Electrical	29%	1.32	2.40	.856
10. Electronic	35%	2.38	3.55	.978
11. Electrical-Mech	24%	1.23	2.46	.854
12. Elec'l-Elec'c	26%	1.50	2.80	.922
13. Electronic-Mech	29%	1.55	2.75	.934
14. Physical Labor	69%	2.98	2.74	.833
15. Med-Patient Care	5%	0.19	1.11	.954
16. Med-Equip Orient	4%	0.18	1.08	.971
17. Med-Procedures	6%	0.26	1.21	.930
18. Simp Nontech Procs	68%	3.18	2.82	.478
19. Commun-Oral	76%	4.82	3.37	.882
20. Comm-Written	68%	4.01	3.33	.886
21. General Tasks	63%	3.58	3.21	.660
22. Reasoning/ Planning	66%	4.15	3.41	.851
23. Science/Math	37%	1.92	2.87	.872
24. Special Talents	22%	1.27	2.63	.697
25. Supervisory	66%	3.46	2.88	.585
26. Training	91%	5.55	2.49	.600

As expected, there were large differences in the extent to which task categories were endorsed as being "part of" the job. This is consistent with the heterogeneity of 47 AFSs surveyed (see Table 1). Table 2 also shows Relative Time Spent (RTS) rating means and standard deviations. RTS responses that were "missing" because a task category was not part of the job were coded "0" to indicate "No time spent." Also as expected, mean RTS ratings varied considerably across task categories.

Interrater reliabilities (intraclass correlations, ICCs) for RTS ratings are also shown in Table 2. ICC (1,$\underline{k}$) indexes the reliability of the mean of $\underline{k}$ judges' ratings (Lahey, Downey, & Saal, 1983; Shrout & Fleiss, 1979), and in the present study, there was a mean of 14.4 respondents from each of the 47 AFSs (i.e., $\underline{k}$ = 14.4). With the exceptions of Simple Nontechnical Procedures, General Tasks, Special Talents, Supervisory, and Training categories, most ICCs for the RTS ratings were high. Lower interrater reliabilities for the Simple Nontechnical Procedures and general task categories indicate that they may not have been defined concretely. On the other hand, lower reliabilities of the Supervisory and Training categories likely reflected restricted between-AFS variance on RTS ratings, since performance in most all AFSs involves some training and supervision of others. That is, since ICC is based on a comparison of between-job variance and within-job variance in ratings, lower between-job variance will lead to lower ICCs (James, Demaree, & Wolf, 1984).

Intercorrelations among RTS ratings indicated some redundancy among rating categories, especially among Mechanical-, Electrical-, Medical-, and Clerical-oriented categories. This suggested that some of the task categories could be combined with little loss in discriminatory power. To explore this possibility, we conducted a principal components analysis on the RTS intercorrelation matrix and, based on examination of the eigenvalue plot, retained a six-component solution. Significant varimax-rotated component loadings are shown in Table 3.

Table 3. Principal Components Analysis of SKQ Relative Time Spent Ratings

Task Category	Principal Component I	II	III	IV	V	VI
1. Clerical					.800	
2. Computational				.523	.475	
3. Office Equip Oper.					.763	
4. Mechanical		.713				
5. Simple Mech.		.780				
6. Complex Mech.	.393	.571				
7. Mech-Electrical	.544	.626				
8. Mech-Electronic	.688	.411				
9. Electrical	.807					
10. Electronic	.826					
11. Electrical-Mech	.850					
12. Elec'l-Elec'c	.880					
13. Electronic-Mech	.880					
14. Physical Labor		.692				
15. Med-Patient Care			.922			
16. Med-Equip Orient			.870			
17. Med-Procedures			.853			
18. Simp Nontech Procs		.469				
19. Commun-Oral				.477	.419	.387
20. Comm-Written				.525	.499	
21. General Tasks				.409		
22. Reasoning/Planning				.651		
23. Science/Math				.687		
24. Special Talents				.653		
25. Supervisory						.744
26. Training						.741

The first two components were clearly interpretable as I: Electrical/Electronic, and II: Mechanical/Maintenance, although these overlapped somewhat. Component III represented Medical tasks, Component IV: Technical activities, Component V: Clerical functions, and Component VI: Managing/Developing others. As would be expected, General verbal and quantitative activities (i.e., Computational, Communicative - Oral, and Communicative - Written) had multiple loadings.

Overall, results in Tables 1 through 3 indicated that (a) SMEs generally provided reliable judgments of the Relative Time Spent performing tasks described by the USAFOMC task categories, (b) SME judgments relating to this taxonomy

differentiated among AFSs' task content, and (c) at least six broad taxonomic categories (Electrical, Mechanical, Medical, Technical, Clerical, and Managing Others) were descriptive of differences in AFSs' task contents.

General Work Inventory

The third source of information for this effort was a data set from administration of the General Work Inventory (GWI, Ballentine & Cunningham, 1981). The GWI was developed to meet needs for a shorter, more practical version of the OAI. Both the GWI and the OAI were developed from an "ergometric" perspective, or "the application of psychometric principles and procedures to the study of human work" (Cunningham, 1988, p. 975). Unlike the Position Analysis Questionnaire (PAQ, McCormick, 1976), which was designed to describe general "worker-oriented" characteristics of jobs, the GWI attempts to capture more specific "job-oriented" content of jobs and is designed to "achieve as much specificity in description as possible, while retaining applicability to the general population of jobs" (Cunningham et al., 1983, p. 233).

GWI work elements are organized into eight sections: A. Sensory Requirements, B. Information Elements, C. General Mental Requirements, D. General Physical Requirements, E. Physical Activities, F. Interpersonal Activities, G. Work Conditions, and H. Job Benefits/Opportunities. GWI items are rated on 9-point "Part-of-Job" (Sections A-F) or "Extent-of-Occurance" scales (Sections G and H) (see Ballentine & Cunningham, 1981). Conceptually, these major divisions correspond to the components in the information processing paradigm presented by Cunningham et al. (1983). Since our focus was on describing job differences in task content (rather than the various contexts within which work is performed), our analyses were restricted to sections B through F of the GWI.

Data Collection

The GWI, along with detailed rating instructions, was mailed to approximately 2500 experienced (technicians and superintendents) USAF enlisted personnel in 180 AFSs in the Fall of 1982. Usable responses were obtained from 2122 respondents in 180 AFSs (see Ballentine & Cunningham, 1981 for details).

Analyses and Results

We conducted principal components analyses (PCAs) on GWI sections B through F items (217 items). Inspection of the eigenvalues for the first 100 components suggested the presence of twenty to thirty-five "significant" components.

We subsequently conducted additional PCAs retaining 20-, 28-, 32-, and 35-component solutions based on breaks in the eigenvalue plot. Generally speaking, these analyses suggested the presence of (a) two broad "Mechanical" and "Electrical/Electronic" components, (b) several other specific, interpretable

components, many of which were consistent across solutions, and (c) a small number of uninterpretable components.

To obtain finer distinctions between separate aspects of Mechanical and Electrical/Electronic activities, we conducted separate PCAs (a) on the items which loaded significantly on either of the first two broad Mechanical or Electrical/Electronic components, and (b) on the remaining items (GWI items in sections B - F which did not load significantly on either the Mechanical or Electrical/ Electronic components). Three-, four-, and five-component solutions were retained for the first set of items, and 18-, 26-, and 30-component solutions were retained for the second set of items. A summary of findings from these separate PCAs is presented in Table 4, where components identified from PCAs of the GWI are shown along with the revised USAFOMC task categories for comparison.

Table 4 shows that relative to the USAFOMC task categories, task categories derived from PCAs of the GWI (a) provided more detailed definitions of task content in certain areas (e.g., Clerical, Simple Physical Labor, and Special Talents), (b) combined certain other USAFOMC task categories (e.g., in the Mechanical, Electrical/Electronic, and Medical areas), and (c) identified specific task categories that were not specified by the USAFOMC taxonomy (e.g., Manufacturing, Construction, and Engineering). However, these results did not identify meaningful subcategories of Electrical/Electronic tasks. The GWI, being a "general" work inventory, did not capture needed distinctions among electrical and electronic job activities, which are a significant part of a large number of Air Force jobs, particularly in the aircraft maintenance area. Consequently, additional data obtained on an Electronics Principles Inventory were analyzed to address this need.

Table 4. Comparison Between USAFOMC and GWI Task Taxonomies

USAFOMC Task Categories	GWI Task Categories
1. Clerical	1. Clerical
	2. Personnel
	3. Maintaining Inventories
	4. Legal/Contractual
2. Computational	5. Computational
3. Office Equipment	
4. Mechanical	6. Mechanical - Maintenance
5. Simple Mechanical	
6. Complex Mechanical	
7. Mechanical-Electrical	
8. Mechanical-Electronic	
9. Electrical	7. Electrical/Electronic
10. Electronic	
11. Electrical-Mechanical	
12. Electrical-Electronic	
13. Electronic-Mechanical	
14. Simple Physical Labor	8. Physical/Manual Labor
	9. Semi-Skilled Labor
	10. Transporting/Shipping
	11. Manufacturing/Fabricating
	12. Building Construction
	13. Construction: Other than Buildings
15. Medical-Patient Care	
16. Medical-Equip Oriented	14. Medical/Health
17. Medical-Procedures	
18. Simple Nontech Procedures	15. Apprenticing
19. Communication-Oral	
20. Communication-Written	16. Communication
21. General Tasks or Procs	
22. Reasoning/Planning/Org	17. Problem Solving
23. Scientific Math Reasoning or Calculations	18. Scientific/Technical
	19. Biological
	20. Physical Sciences
	21. Engineering
	22. Social Sciences/Services
24. Special Talents	23. Artistic - Visual
	24. Entertaining
	25. Vending/Merchandising
	26. Food Preparation
	27. Animal Care
	28. Fabric/Rope Work
	29. Operating Audio/Visual Equipment
	30. Operating Rail Vehicles
	31. Flying Vehicles
25. Supervisory	32. Managing/Developing/ Influencing Others
26. Training	
	33. Policing/Surveillance

Electronics Principles Inventory

The fourth source of data for this study came from administration to 2494 airmen of the Electronics Principles Inventory (EPI) developed at the USAFOMC for the purpose of training course validation. The EPI contains 1,257 items covering the full scope of electronics principles or fundamentals as defined for technical training courses, and by instructors and supervisors of these courses. The EPI instructs respondents to indicate whether each principle is used on their present job (responses are in a binary yes/no format). The EPI has been used operationally by the Air Training Command to validate training courses for several years which, along with extensive validation studies, attests to the validity of the instrument (Ruck, 1986).

The 1257 EPI items are divided into 39 categories of electronics principles. Responses from 2494 respondents were averaged within categories to yield 39 scores indicating the percentage of electronics principles within each of the categories used. PCAs were computed on these category percentage scores, and four-, five-, and six-component solutions were retained based on breaks in the eigenvalue plot. The five-component solution was the most interpretable. These five components, along with significant varimax-rotated loadings are shown in Table 5.

Table 5. EPI Varimax-Rotated Five Component Solution

Component	Significant Component Loading	Electronics Principle
I. Complex Electronic Circuit Maintenance	.7715	Electrontube Amplifier Circuits
	.7176	Tubes
	.6996	Limiter & Clamper Circuits
	.6849	Wave Shaping Circuits
	.6836	Multivibrators
	.6707	Oscillators
	.6682	Coupling Circuits
	.6514	Resistive Capacitive Inductive Circuits
	.6469	Power Supply Filters
	.6183	Frequency Sensitive Filters
	.6175	Resonant Cavities
	.5966	Power Supply Voltage Regulators
	.5679	Magnetic Amplifiers
II. Digital Systems Maintenance	.7481	Digital Logic Numbering Systems
	.7393	Digital Circuits
	.6974	Digital To Analog & Vice Versa
	.6962	Computers
	.5372	TV & Laser & Infrared Systems
III. Communication Systems Maint.	.7727	Antennas
	.7509	Connections
	.7295	Radio Freq Measurements
	.6314	Radio Freq Calculations
	.5600	Signal Generators
	.5429	Oscilloscopes
	.5358	Microwave Oscillators & Amps
	.4767	Transmitters & Receivers
IV. Basic Electrical/ Electronic Repair	.8024	Multimeters
	.7845	Direct-Alternating Current
	.7539	Electro-Mechanical Devices
	.6787	Soldering & Solderless Connections
V. Electronic Peripherals Maintenance	.7919	Storage Type Display Tubes
	.5532	Microphones & Speakers
	.4978	Photosensitive Devices

Synthesis of Results

While our analyses of SKQ, GWI, and EPI data succeeded in identifying potential redundancies among certain USAFOMC task categories, areas in which these categories should be expanded toward specificity and concreteness, and additional concrete task content categories that were descriptive of USAF enlisted job content, neither the SKQ, the GWI, nor the EPI were designed specifically for the taxonomic purposes of the present research. Consequently, we synthesized the empirical results presented here, existing literature on work taxonomies, and operational needs of the USAF, in developing an eclectic task taxonomy to support cross-AFS transferability of skills research.

Some of the GWI task categories in Table 4 were omitted in the development of this taxonomy because (a) their task content overlapped logically with others' (e.g., Transporting/Shipping activities were included in the categories Maintaining Inventories, Mechanical Systems Operation, and Physical/Manual Labor), (b) their task content had little or no operational implications for the USAF (e.g., Vending/Merchandising), or (c) they were too job-specific (e.g., Flying Vehicles). Other categories were expanded to be consistent with actual differences in task content in enlisted AFSs (e.g., Mechanical Systems Operation vs. Mechanical Systems Maintenance and Medical - Patient Care vs. Medical - Technical). Appendix B lists the names and definitions of the resulting revised task taxonomy.

Table 6 compares the USAFOMC task categories with those defined on the basis of an integration of the empirical results presented earlier, prior research on task taxonomies (Fleishman & Quaintance, 1984), and operational implications for the USAF. Although similar in some respects to the USAFOMC taxonomy, the taxonomy in Appendix B is supported by empirical evidence, defines task content areas in much more concrete terms (especially the electrical/electronic and mechanical areas), and redefines several of the USAFOMC task categories (e.g., Simple Physical Labor, General Tasks or Procedures, Simple Nontechnical Procedures and Special Talents) into more concrete task categories (e.g. Manufacturing/Fabricating, Construction, Artistic, Food Preparation, and Animal Care).

Table 6. Comparison Between USAFOMC and Candidate Task Taxonomies

USAFOMC Task Categories	Candidate Task Categories
1. Clerical	1. Clerical
	2. Personnel
	3. Maintaining Inventories
2. Computational	4. Computational
3. Office Equipment	
4. Mechanical	5. Mechanical Systems Maint.
5. Simple Mechanical	
6. Complex Mechanical	6. Mechanical Syst.Operation
7. Mechanical-Electrical	7. Complex Electronic Circuit
8. Mechanical-Electronic	Maintenance
9. Electrical	8. Digital Systems Maintenance
10. Electronic	9. Communication Syst. Maint
11. Electrical-Mechanical	10. Basic Electrical/
	Electronics Repair
12. Electrical-Electronic	
13. Electronic-Mechanical	11. Elec. Peripherals Maint
14. Simple Physical Labor	12. Physical/Manual Labor
	13. Manufacturing/Fabricating
	14. Construction
15. Medical-Patient Care	15. Medical-Patient Care
16. Medical-Equip Oriented	
17. Medical-Procedures	16. Medical-Technical
18. Simple Nontech Procedures	
19. Communication-Oral	17. Oral & Written Comm.
20. Communication-Written	
21. General Tasks or Procs	
22. Reasoning/Planning/Org.	18. Planning & Problem Solving
23. Scientific Math Reasoning	19. Science & Engineering
24. Special Talents	20. Artistic: Audio & Visual
	21. Food Preparation
	22. Animal Care
	23. Fabric/Rope Work
25. Supervisory	24. Managing Others
26. Training	25. Training
	26. Surveillance

Evaluation of the Revised Task Taxonomy

Desirable properties of a useful classification system (taxonomy) are that classification decisions are face valid to users of the system, characteristics of objects to be classified should be measured reliably, classification dimensions should be nonredundant, and classifications should result in meaningful groups of objects. In the following sections we describe our evaluation of the taxonomy shown in Appendix B along these criteria using data collected using a revised version of the SKQ.

Development of Revised Skills/Knowledge Questionnaire (RSKQ)

Although the basic format was similar, two changes were made to the earlier version of the SKQ in designing a revised Skills/Knowledge Questionnaire (RSKQ) for the purpose of evaluating the taxonomy shown in Appendix B. First, questionnaire instructions were rewritten toward brevity and clarity. Second, and more importantly, task rating items were changed from the USAFOMC task categories to those shown. As with the earlier version of the SKQ, respondents were asked to make three judgments regarding each task category: (a) a binary (yes/no) Part-of-Job rating, (b) a 9-point Relative Time Spent rating, and (c) a 9-point Months to Proficiency (MTP) rating.

Data Collection

Using the same criteria as in the earlier SKQ survey, 43 AFSs were targeted for data collection. These are shown in Table 7. In July 1989, the RSKQ, along with a cover letter, detailed rating instructions, and task category definitions, was mailed to 1565 supervisors in the 43 AFSs shown in Table 7. Usable surveys were returned by 836 respondents for a response rate of 53%. The typical respondent was male (91%), had some college education (mean education = 13.26 years), supervised five others (mean = 4.86), had been in the job just under 3 years (mean = 32.72 months), and in the Services over 15 years (average = 183.63 months).

Table 7. Air Force Specialties Surveyed With the RSKQ

AFSC	Specialty TitleArea	MAGE
113x0c	- *Flight Engineer	G
114x0	- Aircraft Loadmaster	M
207x1	- *Morse Systems Operator	A
241x0	- *Safety Specialist	G
242x0	- *Disaster Preparedness	G
251x0	- *Weather Specialist	G
271x1	- Airfield Management Specialist	A
272x0	- *Air Traffic Control Operator	G
276x0	- Aerospace Control & Warning Systems	G
303x2	- Aircraft Control & Warning Radar	E
304x0	- *Wideband Communication Equip Spec	E
304x4	- Ground Radio Communications Spec	E
324x0	- Precision Msmt Equip Lab Spec	E
423x0	- Aircraft Electrical Systems Spec	E
452x4	- Tactical Aircraft Maintenance Spec	M
454x1	- Aerospace Ground Equipment Mech	M&E
455x2	- Avionic Communication Specialist	E
457x0	- Strategic Aircraft Maint Spec	M
461x0	- Munitions Systems Specialist	M/E
462x0	- Aircraft Armament Systems Spec	M/E
472x1	- Special Vehicle Mechanic	M
542x0	- Electrician	E
545x0	- Refrigeration and A/C Spec	M/E
551x0	- Pavements Maintenance Specialist	M
551x1	- Construction Equipment Operator	M
553x0	- Engineering Assistant Specialist	G
571x0	- Fire Protection Specialist	G
603x0	- *Vehicle Operator/Dispatcher	M
631x0	- Fuel Specialist	M&G
645x0	- Inventory Management Specialist	A/G
645x1	- *Materiel Storage & Distribution	G
645x2	- *Supply Systems Analysis Specialist	A
651x0	- *Contracting Specialist	A
661x0	- *Logistics Plans Specialist	A
702x0	- *Administration Specialist	A
732x0	- *Personnel Specialist	A
741x1	- Fitness and Recreation Specialist	A
791x0	- Public Affairs Specialist	G
811x0	- *Security Specialist	G
811x2	- *Law Enforcement Specialist	G
902x0	- Medical Service Specialist	G
906x0	- Medical Administrative Spec	G
981x0	- Dental Assistant	G

Note. AFSC = Air Force Specialty Code.
M = Mechanical, A = Administrative, G = General, E = Electronic. *AFSCs also surveyed with the 1988 SKQ.

Results

The first criterion we used to evaluate the taxonomy in Appendix B was to determine its potential face validity to users. Some results bearing on this question are shown in Table 8. Here, the percentage of respondents making "part-of-job" endorsements varied widely across the task categories, indicating that tasks in some of the task categories are widely performed (e.g., Clerical, Oral/Written Communication, and Training) while others are relatively less often performed. More importantly, however, Table 8 also lists a representative job title for each task category in which a high proportion of respondents endorsed as part of their job. These jobs are among those expected to have high part-of-job endorsements for the task categories.

Table 8. RSKQ Descriptive Statistics: Part-of-Job Ratings

Task Category	Part of Job	Representative AFS with High Percent "Part-of-Job"
Clerical	73%	702x0 - Administration Specialist
Personnel	49%	732x0 - Personnel Specialist
Maint Inventories	58%	645x0 - Inventory Management
Computational	52%	113x0c- Flight Engineer
Mech Syst Maint	47%	454x1 - Aerospace Ground Equip Mech
Mech Syst Operation	52%	545x0 - Refrigeration & A/C Maint
Complex Elec Circuit	21%	324x0 - Precision Measurement Equip
Digital Syst Maint	17%	304x0 - Wideband Comm. Equip Op.
Commun Syst Maint	18%	304x4 - Ground Radio Communications
Basic Elec Repair	32%	423x0 - Aircraft Electrical Syst
Elec Peripherals	13%	304x4 - Ground Radio Communications
Physical/Man'l Labor	68%	551x1 - Construction Equip Operator
Manufacturing/Fabr	16%	551x0 - Pavements Maintenance
Construction	16%	551x0 - Pavements Maintenance
Med-Patient Care	8%	902x0 - Medical Service Spec
Med-Technical	5%	902x0 - Medical Service Spec
Oral/Written Commun	83%	791x0 - Public Affairs Spec
Planning/Prob Solv	70%	241x0 - Safety Specialist
Science/Engineering	22%	251x0 - Weather Specialist
Artistic - A/V	17%	242x0 - Disaster Preparedness
Food Preparation	3%	114x0 - Aircraft Loadmaster
Animal Care	2%	811x2 - Law Enforcement Spec
Fabric/Rope Work	3%	571x0 - Fire Protection Spec
Managing Others	68%	303x2 - Aircraft Control & Warning
Training	87%	242x0 - Disaster Preparedness Spec
Surveillance	24%	811x2 - Law Enforcement Spec

Note. See Appendix B for detailed definitions of task categories. AFSs shown are representative of those having the highest proportion of respondents indicating that tasks within each category were part of their job.

A second criterion concerned the reliability with which the taxonomic categories are used in describing jobs. There are a number of ways in which rating reliability can be assessed (Jones, Johnson, Main & Butler, 1983), but the reliability of job analysis data most often is assessed using either Pearson interrater reliability correlations or intraclass correlations (ICCs) (Kavanagh & Lance, 1989). We assessed the reliability of RSKQ Relative Time Spent (RTS) ratings in both ways.

The average Pearson correlation among different raters within the same AFS was $\underline{r} = 0.57$. The Spearman-Brown correction for the reliability of the average number of respondents per AFS (19.44) was $\underline{r} = 0.96$. Finally, ICCs are shown along with RTS means and standard deviations in Table 9. With the exception of Managing Others (ICC = 0.605), ICCs were uniformly high. Thus, both Pearson correlations and ICCs supported the reliability of RTS ratings on the Taxonomy in Appendix B.

Table 9. Descriptive Statistics and Intraclass Correlations: RSKQ Relative Time Spent Ratings

Task Category	Mean	SD	ICC (1,k)
Clerical	3.47	2.95	.901
Personnel	1.97	2.47	.782
Maint Inventories	2.40	2.64	.866
Computational	2.36	2.80	.868
Mech Syst Maint	2.85	3.47	.972
Mech Syst Operation	2.96	3.39	.923
Complex Elec Circuit	1.92	2.79	.979
Digital Syst Maint	1.03	2.47	.979
Commun Syst Maint	1.16	2.68	.987
Basic Elec Repair	1.97	3.21	.987
Elec Peripherals	0.63	1.89	.926
Physical/Man'l Labor	3.56	3.22	.910
Manufacturing/Fabr	0.58	1.57	.779
Construction	0.72	2.01	.962
Med-Patient Care	0.45	1.77	.982
Med-Technical	0.29	1.45	.974
Oral/Written Commun	4.85	3.01	.868
Planning/Prob Solv	3.91	3.07	.748
Science/Engineering	1.17	2.48	.912
Artistic - A/V	0.74	1.92	.920
Food Preparation	0.07	0.47	.923
Animal Care	0.06	0.50	.754
Fabric/Rope Work	0.11	0.73	.714
Managing Others	3.44	2.87	.605
Training	5.14	2.71	.763
Surveillance	1.34	2.74	.926

Note. ICC(1,k) indexes the reliability of the mean of k judges' ratings (mean k = 19.4, for ratings in this table).

A third criterion concerns the distinctness of a taxonomy's categories. We examined this question in two ways. First, we calculated the average interitem correlation in the 26 x 26 matrix of correlations among the Relative Time Spent (RTS) ratings, with $\underline{r} = 0.09$. This indicated that, on the average, the task categories addressed distinct sets of job tasks.

Second, we conducted a principal components analysis of the RTS intercorrelations. An eigenvalue plot suggested a four-component solution, which is shown in Table 10. These components accounted for 47% of the variables' variance, and were are clearly interpretable as I: Electronic, II: General and Administrative, III: Mechanical, and IV: Medical. Together with the correlational results above, these results suggest that the taxonomic categories were distinct, but still could be related to a more global categorization scheme.

Table 10. Varimax Rotated Principal Components Results for RSKQ Relative Time Spent Ratings: Four Component Solution

	Principal Component			
Task Category	I	II	III	IV
Clerical		.583	-.330	
Personnel		.634		
Maint Inventories		.333	.338	
Computational		.523		
Mech Syst Maint		.788		
Mech Syst Operation		.828		
Complex Elec Circuit	.924			
Digital Syst Maint	.926			
Commun Syst Maint	.915			
Basic Elec Repair	.794			
Elec Peripherals	.792			
Physical/Man'l Labor		.788		
Manufacturing/Fabr		.549		
Construction		.384		
Med-Patient Care				.910
Med-Technical				.900
Oral/Written Commun		.683		
Planning/Prob Solv		.679		
Science/Engineering		.497		
Artistic - A/V		.536		
Food Preparation				
Animal Care				
Fabric/Rope Work				
Managing Others		.611		
Training		.545		
Surveillance		.327		

Note. See Appendix B for detailed definitions of task categories. Only loadings > |.300| are shown.

Finally, perhaps the most important practical criterion for a classificatory system is whether it leads to meaningful classifications. We addressed this issue by determining whether RTS rating profiles clustered AFSs into meaningful job groupings. Specifically, we formed a 43 x 43 matrix of Euclidean distances among the AFSs in Table 7 based on their mean RTS profiles for input to Ward's (1963) hierarchical clustering algorithm. An inverse scree plot suggested either a three- or nine-cluster solution. These are shown in Table 11, where Roman numerals denote the three-cluster solution and upper-case letters designate subgroups in the nine-cluster solution.

The three-cluster solution was clearly interpretable as: I: Mechanical, II: Electronic, and III: General and Administrative. The nine-cluster solution also identified meaningful subgroups. Within the Mechanical cluster, three sub-clusters of AFSs were identified: IA: Mechanical/ Construction, containing AFSs involved in manufacturing and construction, IB: Mechanical, containing AFSs in which mechanical systems maintenance and operation were core activities, and IC: Mechanical/Electrical, containing AFSs in which incumbents perform both mechanically- and electrically-oriented tasks. On the other hand, five relatively homogeneous subclusters were identified within the broader General and Administrative (G&A) cluster: IIIA: G&A - Medical, IIIB: G&A - Surveillance, IIIC: G&A - Clerical, IIID: G&A - Technical, and IIIE: G&A Logistics.

Table 11. AFS Clusters Based on Mean RSKQ Relative Time Spent Profiles

Cluster IA: Mechanical/Construction
551x0 (M)a - Pavements Maintenance Specialist
551x1 (M) - Construction Equipment Operator

Cluster IB: Mechanical
452x4 (M) - Tactical Aircraft Maintenance Specialist
457x0 (M) - Strategic Aircraft Maintenance Specialist
461x0 (M/E) - Munitions Systems Specialist
571x0 (G) - Fire Protection Specialist
631x0 (M&G) - Fuel Specialist

Cluster IC: Mechanical/Electrical
423x0 (E) - Aircraft Electrical Systems Specialist
454x1 (M&E) - Aerospace Ground Equipment Mechanic
462x0 (M/E) - Aircraft Armament Systems Specialist
472x0 (M) - Special Vehicle Mechanic
542x0 (E) - Electrician
545x0 (M/E) - Refrigeration & Air Conditioning Specialist

Cluster II: Electronics
303x2 (E) - Aircraft Control & Warning Radar Specialist
304x0/x4 (E) - Wideband and Ground Radio Communications Specialists
324x0 (E) - Precision Measurement Equipment Laboratory Spec

Table 11 (continued)

455x2 (E) - Avionic Communication Specialist

Cluster IIIA: General & Administrative - Medical
902x0 (G) - Medical Service Specialist
981x0 (G) - Dental Assistant

Cluster IIIB: General & Administrative - Surveillance
207x1 (A) - Morse Systems Operator
272x0 (G) - Air Traffic Control Operator
276x0 (G) - Aerospace Control & Warning Systems Operator
811x0/x2 (G) - Security and Law Enforcement Specialists

Cluster IIIC: General & Administrative - Clerical
651x0 (A) - Contracting Specialist
661x0 (A) - Logistics Plans Specialist
702x0 (A) - Administration Specialist
732x0 (A) - Personnel Specialist
791x0 (G) - Public Affairs Specialist
906x0 (G) - Medical Administrative Specialist

Cluster IIID: General & Administrative - Technical
241x0 (G) - Safety Specialist
242x0 (G) - Disaster Preparedness Specialist
251x0 (G) - Weather Specialist
553x0 (G) - Engineering Assistant

Cluster IIIE: General & Administrative - Logistics
113x0c (G) - Flight Engineer
114x0 (M) - Aircraft Loadmaster
271x1 (A) - Airfield Management Specialist
603x0 (M) - Vehicle Operator/Dispatcher
645x0 (A/G) - Inventory Management Specialist
645x1 (G) - Materiel Storage & Distribution Specialist
645x2 (A) - Supply Systems Analysis
741x1 (A) - Fitness & Recreation Specialist

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[a]MAGE Area assignment: M = Mechanical, A = Administrative, G = General, E = Electronic.

Summary

In summary, results in Tables 8 - 11 support the usefulness of the taxonomy in Appendix B in terms of (a) its face validity, (b) the reliability with which SMEs used it in describing their jobs, (c) the distinctness of its categories, and, perhaps most importantly, (d) its ability to support the formation of meaningful subgroups of jobs.

CONCLUSION

The taxonomy shown in Appendix B is designed to support research on cross-job transferability of skills in the USAF. Compared to more specific taxonomies such as represented by the Position Analysis Questionnaire (PAQ), containing 187 job elements, (McCormick, 1976) or the OAI with 617 work elements (Cunningham, 1988) the present taxonomy's categories are more macro. On the other hand, it permits finer-grained analyses of interjob similarity than, for example, comparisons in Functional Job Analysis terms of people, data, and things (Fine, 1988).

The taxonomy is intended to support research on forecasting the task content and skill requirements for projected USAF jobs, anticipating training needs for new USAF jobs, setting aptitude standards, determining optimal strategies for internal (cross-AFS) retraining assignments, and designing alternative organizational structures for the operation and maintenance of emerging technologies. The utility of a taxonomy such as this already has been demonstrated for allocating tasks to taxonomic categories (Gould et al., 1989), and for estimating cross-job retraining times (Lance et al., 1989). Future research will determine the utility of the taxonomy developed here for its other projected uses.

Future research should also determine how the present taxonomy should be modified. The overall validity of this (or any) work taxonomy should be regarded as tentative in the light of the purpose for which the taxonomy is to be used, changes in the nature of work performed in the job population, and future research findings. In addition, future research should continue to determine the extent to which different taxonomies (e.g., PAQ vs. RSKQ, vs. FJA) and different clustering methods lead to different job groupings. Finally, research should be conducted to examine the relationship between this taxonomy and a skills- or aptitude-based one, thus completing the task-aptitude matrix described by Dunnette (1976).

From a practical standpoint, the development of a valid task taxonomy realizes its payoff in supporting human resources planning. In the military and private-sector organizations alike, the changing future workforce needs requires a means of assessing cross-job transferability of skills. In some cases this will involve transfer across jobs in different job families. Without a means for estimating cross-job transferability of skills, these transfer decisions may be haphazard. Thus, the present research is aimed at helping to resolve this critical applied issue.

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APPENDIX A

USAFOMC Task Taxonomy Categories and Definitions

CLERICAL - Performing secretarial or clerk type functions, such as filing, preparing forms, or answering phones. May involve understanding and application of rules, manuals, or regulations.

COMPUTATIONAL - Performing basic math computations, such as adding, multiplying, dividing, or computing simple averages. May involve understanding and application of rules, manuals, or regulations. Also includes the operation of adding machines or calculators.

OFFICE EQUIPMENT OPERATION - Operating general office equipment such as typewriters, copy machines, or stenographs. Also includes minor maintenance such as changing fluid, changing ribbons, clearing jams, or replacing bulbs.

MECHANICAL - Tasks which involve the manual manipulation of tools or equipment. Also involves those tasks which require an understanding of the mechanical principles and/or actual mechanical works of machinery or its components.

SIMPLE MECHANICAL EQUIPMENT/SYSTEMS OPERATION - Operation of simple equipment, machinery, or systems (other than office equipment) requiring only basic knowledge or understanding of the equipment.

COMPLEX MECHANICAL EQUIPMENT/SYSTEMS OPERATION - Operation of equipment, machinery, or systems (other than office equipment) requiring advanced or in-depth knowledge, complex skills, or significant manual coordination.

MECHANICAL-ELECTRICAL - Tasks involving both mechanical and electrical knowledge or skills but with the primary emphasis of the task being mechanical in nature. (Note: Tasks which appear to have approximately equal emphasis should be grouped according to the more important or critical aspect).

MECHANICAL-ELECTRONIC - Tasks involving both mechanical and electronic knowledge and skills but with the primary emphasis of the task being mechanical in nature. (Note: Tasks which appear to have approximately equal emphasis should be grouped according to the more important or critical aspect). These tasks may also involve some incidental electrical knowledge.

ELECTRICAL - Tasks which involve systems and equipment that produce or transmit electrical power; including transformers, generators, motors, and associated power lines and wiring. May involve small amounts of other components such as mechanical, electronic, or administrative, but the primary aspect is electrical.

ELECTRONIC - Tasks which involve devices, circuits, or systems that conduct or transmit complex electrical signals, such as transistors, resistors, diodes, or printed circuit boards; including wiring, such as coaxial cables which carry coded signals. Requires understanding of principles of electronics and/or the functioning of components. May involve small amounts of mechanical, electrical, or administrative components but the primary aspect is electronic.

ELECTRICAL-MECHANICAL - Tasks which involve both electrical and/or mechanical skills but the primary aspect is electrical.

ELECTRICAL-ELECTRONIC - Tasks which involve both electrical and electronic skills and knowledge. Does not involve significant amounts of mechanical skills.

ELECTRONIC-MECHANICAL - Tasks which involve both electronic and mechanical skills and/or knowledge, but the primary aspect is electronic.

SIMPLE PHYSICAL LABOR - Tasks involving simple manual labor, such as sweeping, lifting, carrying, or cleaning. Cleaning tasks would ordinarily be included in this category if no technical knowledge is involved or required.

MEDICAL-PATIENT CARE - Tasks whose predominant aspects involve physical or verbal interaction with patients.

MEDICAL-EQUIPMENT ORIENTED - The primary aspect of these tasks involves the use or operation of some type of medical equipment, instruments, or supplies. May involve some degree of patient interaction. Usually, medical X-ray or medical lab tasks would be grouped under this category.

MEDICAL PROCEDURES - The primary aspect of these tasks involves some procedure in a medical lab or operating room, etc. May involve some degree of patient interaction.

SIMPLE NONTECHNICAL PROCEDURES - These tasks are usually simple in nature, somewhat procedural and do not require a great deal of knowledge, training, or experience to perform; require only simple instructions or directions; may involve following a checklist.

COMMUNICATIVE-ORAL - Tasks whose primary aspect is communicative in nature; may involve the operation of communication devices, such as radios or telephones, when the primary emphasis of the task is to communicate something rather than strictly the operation of the device.

COMMUNICATIVE-WRITTEN - Tasks that involve communicating in a written manner; more than just a preparation of a standard form or standard report requiring filling blanks.

GENERAL TASKS OF PROCEDURES - Any general task or technical procedure that does not involve significant amounts of mechanical, electrical, or electronic skills or knowledge and is not primarily administrative in nature, yet does require some detailed knowledge to be performed. (Note: If a task involves some mechanical skill, or requires the the individual to know electrical or electronic principles, it should be categorized under those categories).

REASONING/PLANNING/ANALYZING - Tasks whose primary aspects involve reasoning or interpretive skills. May include coordinating when it involves reasoning problems or answering inquiries. (Note: Does not involve normal supervisory planning such as assigning work, evaluating performance, interpreting regulations, etc.).

SCIENTIFIC MATH REASONING OR CALCULATIONS - These tasks involve more than simple arithmetic computations; may involve using or applying formulas, using or preparing tables or charts; may require knowledge of physics, chemistry, geography, etc.; may involve use of equipment such as gauges, slide rules, plotters, or calculators.

SPECIAL TALENTS - Tasks which involve skills which cannot be completely taught, such as playing musical instruments, drawing or composing. Usually involves some elements of creativity.

SUPERVISORY - Tasks whose primary aspects involve supervision of others, including assigning individuals to work load, generating schedules, assessing performance, etc.

TRAINING - Tasks associated with the giving of job-oriented training.

APPENDIX B

Revised Task Taxonomy Category Definitions

CLERICAL Tasks such as filing, preparing forms, answering telephones, typing reports, and proofreading. Operating office equipment such as computers, typewriters, calculators, duplicating machines. Processing information related to military regulations, federal or state laws, contracts, and legal documents.

PERSONNEL Processing data/information about individuals, such as employment applications, performance reviews, disciplinary reports, media releases, production records, personnel forecasts, training records, counseling information, and social services.

MAINTAINING INVENTORIES Maintaining materials/merchandise/ supplies/equipment records. Ordering, receiving, maintaining, routing and accounting for inventory. Preparing, analyzing and maintaining records of financial dealings, property, assets.

COMPUTATIONAL Performing numerical operations such as adding, subtracting, multiplying, dividing. Computing statistics using formulas and equations. Locating statistics/data in graphs/ tables/charts. Using calculators or adding machines to solve math problems.

MECHANICAL SYSTEMS MAINTENANCE Performing mechanical repair and maintenance activities such as maintaining, repairing, assembling, installing, troubleshooting, and adjusting/tuning mechanical systems. Lubricating, bonding and sealing, and using tools (such as a hammer, screwdriver, or block and tackle) to repair/maintain mechanical systems.

MECHANICAL SYSTEMS OPERATION Operating mechanical equipment such as a meat slicer, sewing machine, printing press, bulldozer, road grader, forklift or tractor. Driving/operating/piloting vehicles. Using mechanical tools such as an electric drill, air wrench, chain saw, or jack hammer.

COMPLEX ELECTRONIC CIRCUIT MAINTENANCE Maintaining and repairing equipment containing complex electronic circuitry such as electron tube amplifier circuits, tubes, limiter and

clamper circuits, wave shaping circuits, multivibrators, oscillators, coupling circuits, power supply filters, resonant cavities, and magnetic amplifiers.

DIGITAL SYSTEMS MAINTENANCE Maintaining and repairing digital systems such as digital logic numbering systems, computers, television, laser, and infrared systems. Maintaining and repairing equipment which contains digital circuits or processes digital to analog/analog to digital information.

COMMUNICATION SYSTEMS MAINTENANCE Maintaining and repairing communication systems such as antennas, microwave oscillators and amplifiers, signal generators, and transmitters and receivers. Making radio frequency measurements and calculations. Using oscilloscopes.

BASIC ELECTRICAL/ELECTRONIC REPAIR Maintaining and repairing basic electro-mechanical equipment with a working knowledge of multimeters, direct and alternating current, soldering, and solderless connections.

ELECTRONIC PERIPHERALS MAINTENANCE Maintaining and repairing electronic peripheral devices such as storage type display tubes, microphones and speakers, and photosensitive devices.

PHYSICAL/MANUAL LABOR Nontechnical manual and physical tasks such as sweeping, lifting, carrying, cleaning, sawing, lubricating, drilling, cutting, hoisting, chipping, and planing. Using basic tools such as a hammer, paint scraper, shovel, or wheelbarrow.

MANUFACTURING/FABRICATING Making things from materials such as sheet metal, metal tubing, glass, brick, plastic, rubber, paper, or lumber. For example, pressing, mixing, forging, grinding, stitching, forming, melting, or chemically treating materials to manufacture things.

CONSTRUCTION Using construction information such as materials lists, building designs, etc. Building/maintaining structures made of brick, stone, lumber, asphalt, or concrete, such as walls, floors, cabinets, houses, bridges, towers, roads, or runways. Laying/covering with roofing materials, floor coverings, wall paper.

MEDICAL - PATIENT CARE Verbally or physically interacting with patients, e.g., bandaging, giving injections, applying medicines, drawing blood, performing physical therapy.

Reading/interpreting medical charts, thermometer readings, test results.

MEDICAL - TECHNICAL Performing technical procedures in a medical lab or operating room, e.g., operating X-ray machine, microscope, EKG machine, respirator, ultrasound machine.

ORAL AND WRITTEN COMMUNICATION Reading/speaking/writing, understanding words, and expressing ideas, including receiving/processing/initiating letters, books, reports, phone calls, orders, directions/instructions, lectures, contracts; attending/conducting meetings, presentations.

PLANNING/PROBLEM SOLVING Using available information to anticipate/figure out/solve problems, and plan the steps and procedures required to reach a solution to the problem (e.g., identifying a traffic problem and formulating a plan for re-routing traffic).

SCIENCE AND ENGINEERING Collecting/organizing/summarizing technical information, or information about people, events, places. Using systematic/scientific methods to test theories/ products/equipment. Writing reports of results/findings. Using technical information such as aerial photos, weather forecasts, maps, engineering plans, blueprints, circuit diagrams, and other designs/plans for equipment, manufacturing processes, etc.

ARTISTIC - AUDIO/VISUAL Audio and visual art design/production, e.g., photography, movies, recordings, drawings, illustrations, layouts, musical compositions, interior decorations. Performing, e.g., playing musical instruments, singing, dancing, and acting. Operating equipment such as turntables, videotape players, slide projectors, film developing equipment, etc.

FOOD PREPARATION Preparing/cooking food, using/producing menus, recipes, nutrition guides, food requests and estimates.

ANIMAL CARE Caring for animals, including grooming, training, treating, exercising, or tending animals.

FABRIC/ROPE WORK Sewing, stitching, threading, weaving, combining, or separating materials such as fabric, thread, rope, material, fiber, and string.

MANAGING OTHERS Managing/administering/supervising/evaluating

others, e.g., determining goals and coordinating others' activities, assigning work to others and supervising their work, evaluating others' performance, making staffing decisions, conducting group meetings, settling conflicts and enforcing rules.

TRAINING Explaining ideas/procedures to others, demonstrating how a task is done, monitoring learner progress, providing feedback on mistakes, preparing lesson plans, course outlines, etc.

SURVEILLANCE Using codes/symbols (e.g., traffic control "lingo," flag, and hand signals), detecting, visualizing and recognizing objects that are difficult to see (e.g., ships and aircraft at a distance, criminal suspect in a crowd), tracking and pursuing moving targets or objects, using firearms or other handheld weapons, enforcing rules or laws.